US011706532B2

(12) **United States Patent**
Yu et al.

(10) **Patent No.: US 11,706,532 B2**
(45) **Date of Patent: Jul. 18, 2023**

(54) **METHOD FOR PROVIDING IMAGE AND ELECTRONIC DEVICE SUPPORTING THE SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/736,320**

(22) Filed: **May 4, 2022**

(65) **Prior Publication Data**

US 2023/0059077 A1 Feb. 23, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/006268, filed on May 2, 2022.

(30) **Foreign Application Priority Data**

Aug. 18, 2021 (KR) 10-2021-0108816
Oct. 8, 2021 (KR) 10-2021-0133722

(51) **Int. Cl.**
H04N 23/70 (2023.01)
G06T 5/00 (2006.01)
H04N 23/57 (2023.01)

(52) **U.S. Cl.**
CPC ***H04N 23/70*** (2023.01); ***G06T 5/007*** (2013.01); ***H04N 23/57*** (2023.01); *G06T 2207/10024* (2013.01)

(58) **Field of Classification Search**
CPC G06T 2207/10024; G06T 5/007; H04N 23/57; H04N 23/70
See application file for complete search history.

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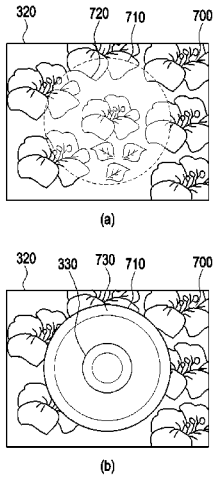
(57) **ABSTRACT**

According to certain embodiments, an electronic device comprises a display; a camera disposed under the display; and a processor configured to, obtain a first image using the camera in a first state in which a first portion of the display corresponding to a position where the camera is disposed is in a first mode, obtain a second image, using the camera in a second state in which the first portion of the display is in a second mode, calculate correction values, based on first data for a first area of the first image and second data for a second area of the second image, wherein the second area of the second image corresponds to the first area of the first image, and correct at least one image among a plurality of images, using the correction values, wherein one of obtain-
(Continued)



ing the first image and obtaining the second image is responsive to the other of obtaining the first image and the second image.

20 Claims, 11 Drawing Sheets

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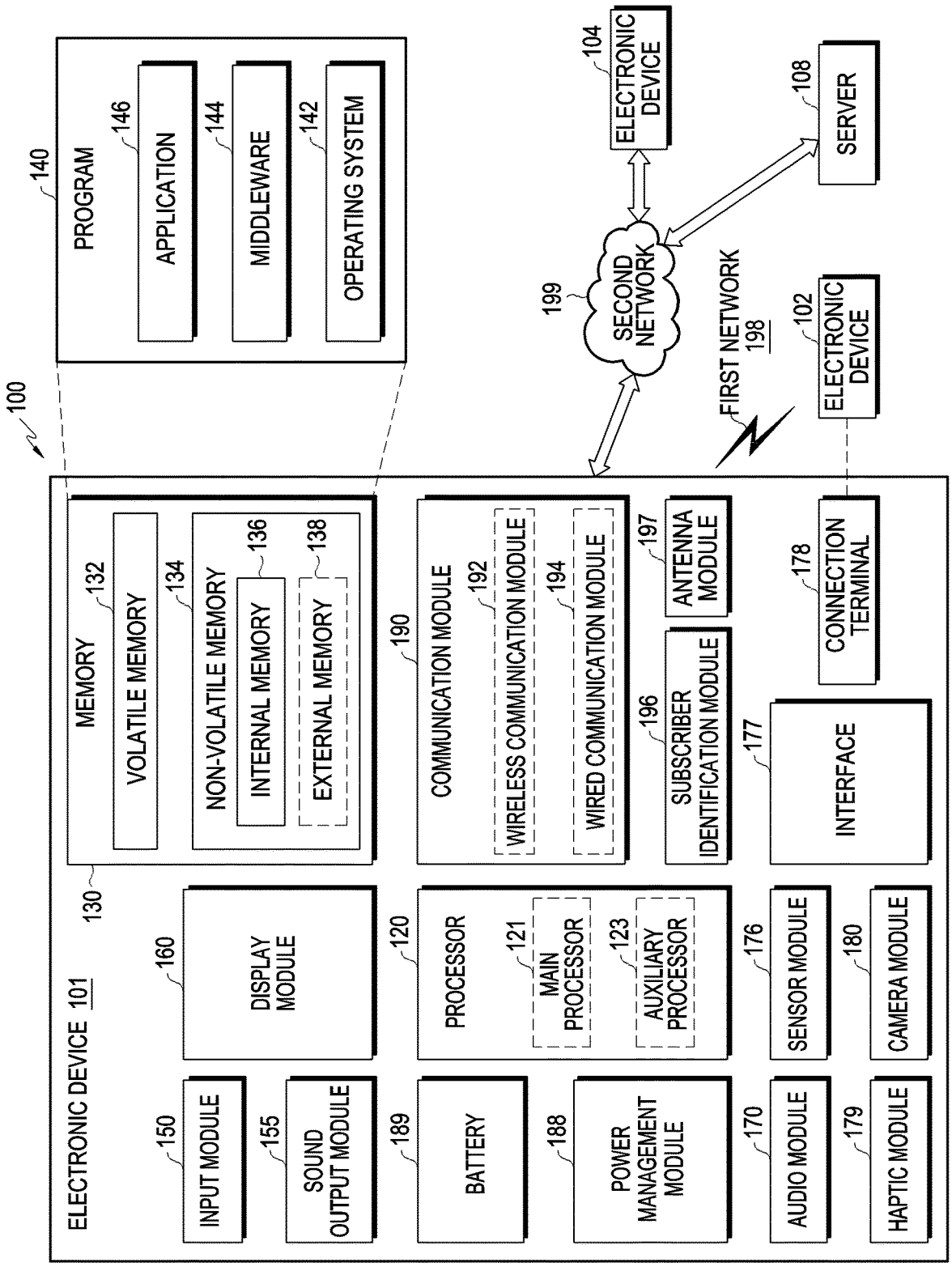

100
ELECTRONIC DEVICE 101
130
MEMORY
132
VOLATILE MEMORY
134
NON-VOLATILE MEMORY
136
INTERNAL MEMORY
138
EXTERNAL MEMORY
190
COMMUNICATION MODULE
192
WIRELESS COMMUNICATION MODULE
194
WIRED COMMUNICATION MODULE
197
ANTENNA MODULE
196
SUBSCRIBER IDENTIFICATION MODULE
177
INTERFACE
178
CONNECTION TERMINAL
160
DISPLAY MODULE
120
PROCESSOR
121
MAIN PROCESSOR
123
AUXILIARY PROCESSOR
176
SENSOR MODULE
180
CAMERA MODULE
150
INPUT MODULE
155
SOUND OUTPUT MODULE
189
BATTERY
188
POWER MANAGEMENT MODULE
170
AUDIO MODULE
179
HAPTIC MODULE
140
PROGRAM
146
APPLICATION
144
MIDDLEWARE
142
OPERATING SYSTEM
199
SECOND NETWORK
FIRST NETWORK
198
104
ELECTRONIC DEVICE
102
ELECTRONIC DEVICE
108
SERVER

FIG. 1

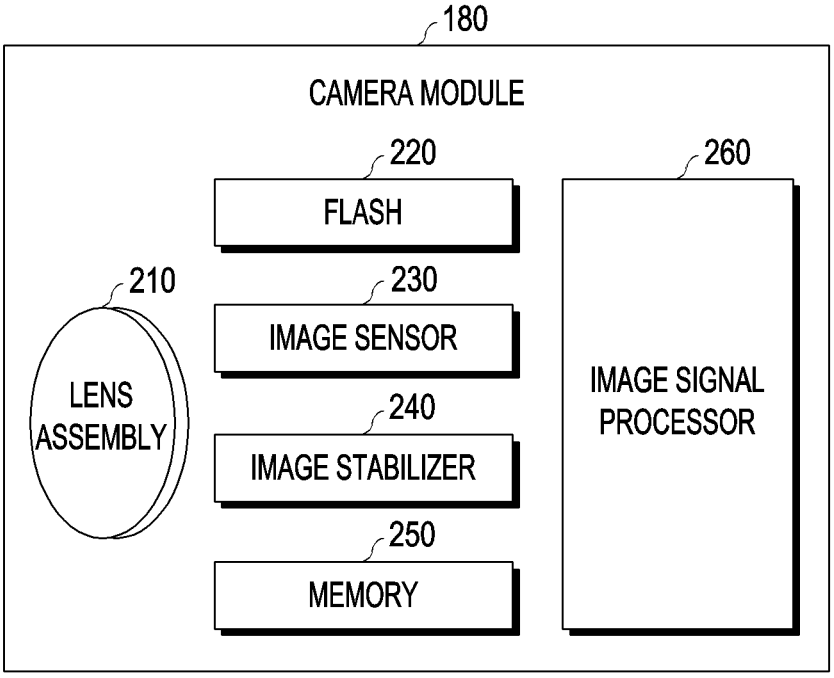

180
CAMERA MODULE
220
FLASH
260
210
230
IMAGE SENSOR
LENS ASSEMBLY
240
IMAGE STABILIZER
IMAGE SIGNAL PROCESSOR
250
MEMORY

FIG. 2

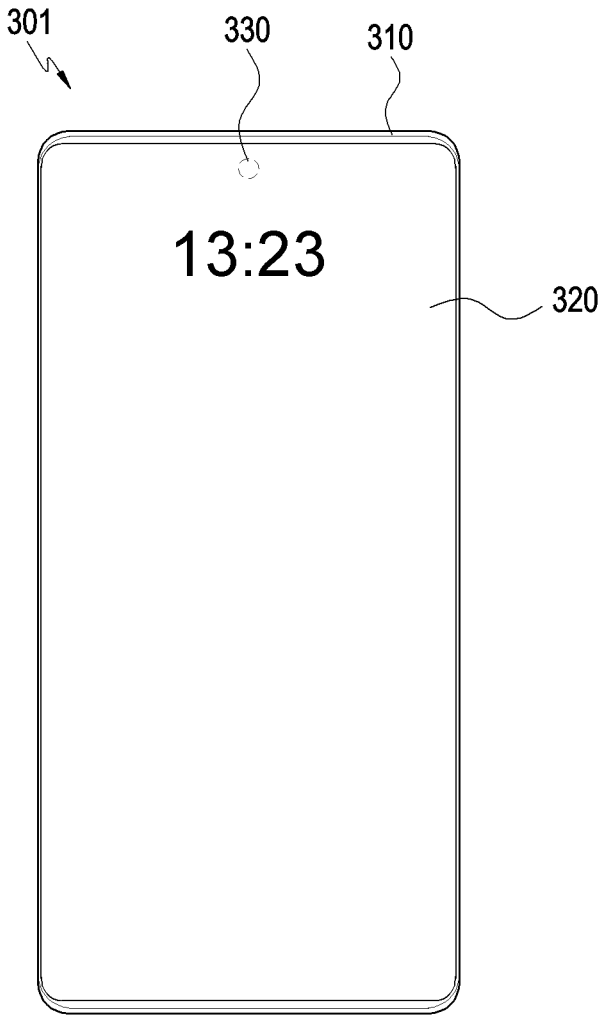


FIG. 3

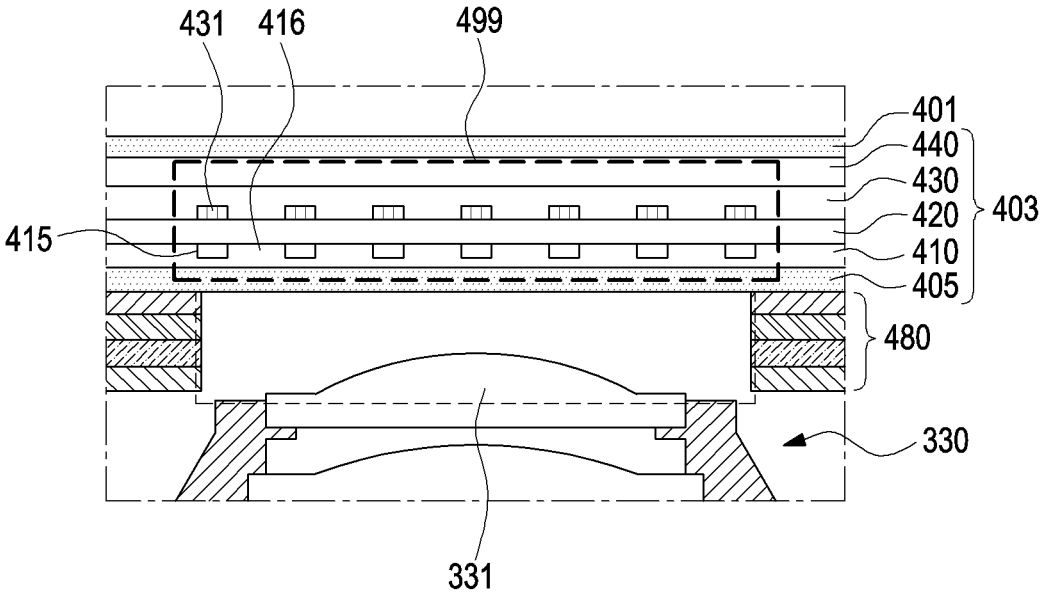


FIG. 4

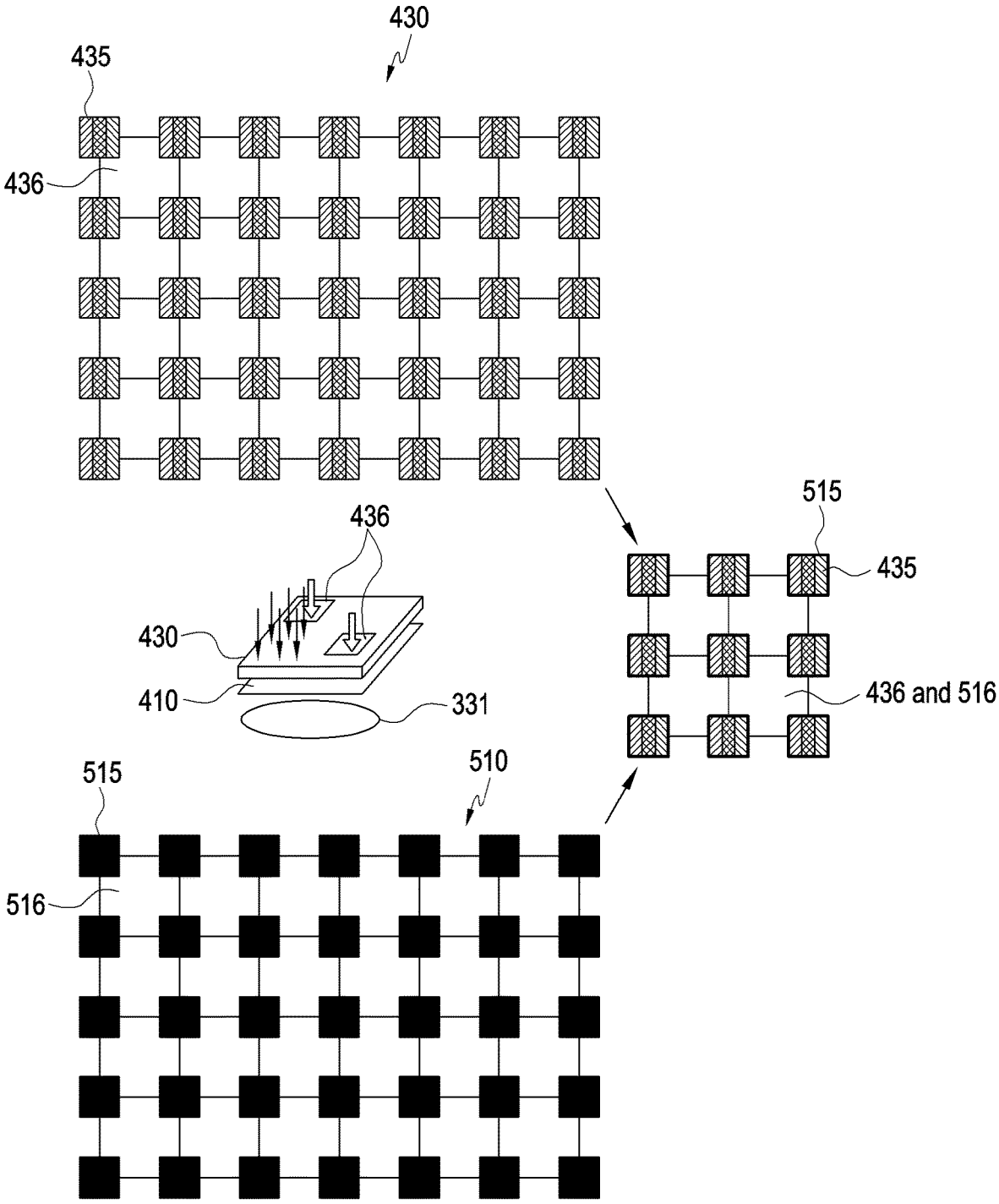


FIG. 5

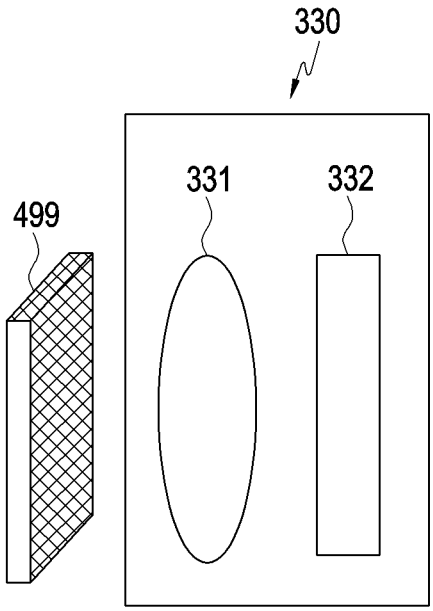
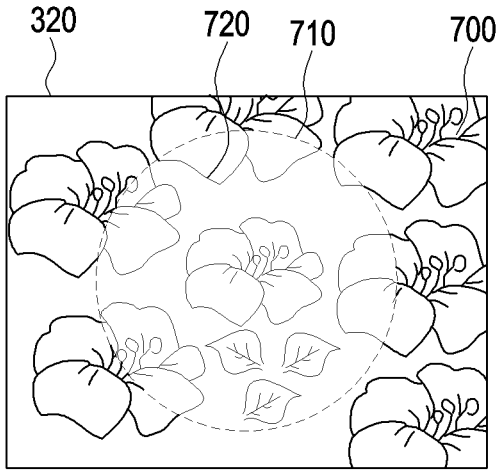
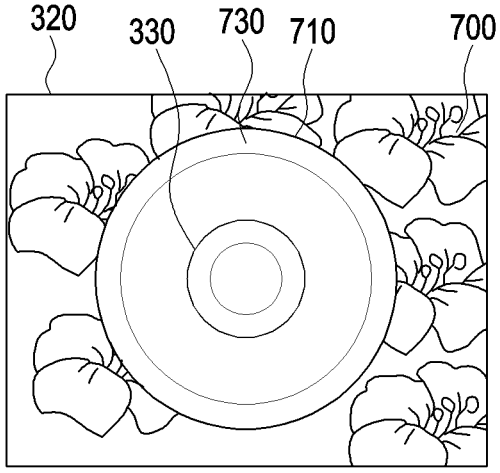


FIG. 6



(a)



(b)

FIG. 7

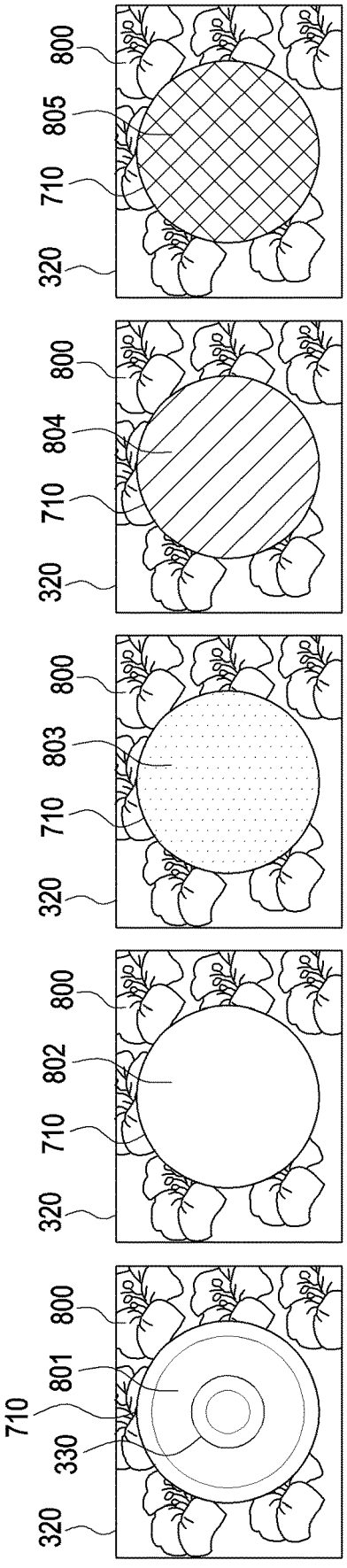

800
805
710
320
(e)
800
804
710
320
(d)
800
803
710
320
(c)
800
802
710
320
(b)
800
801
710
330
320
(a)

FIG. 8

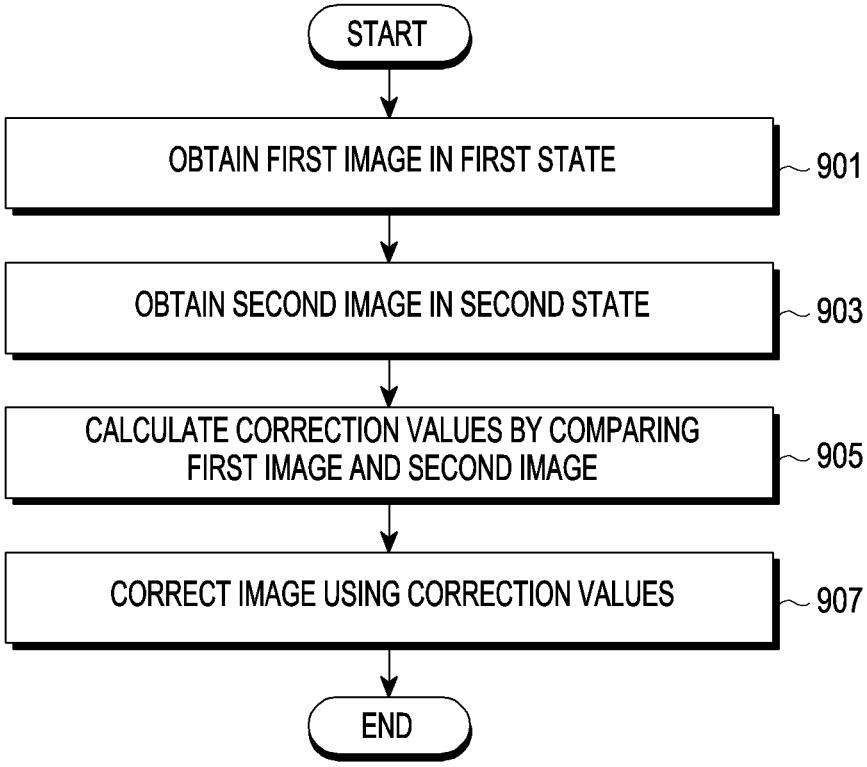

START
OBTAIN FIRST IMAGE IN FIRST STATE
901
OBTAIN SECOND IMAGE IN SECOND STATE
903
CALCULATE CORRECTION VALUES BY COMPARING FIRST IMAGE AND SECOND IMAGE
905
CORRECT IMAGE USING CORRECTION VALUES
907
END

FIG. 9

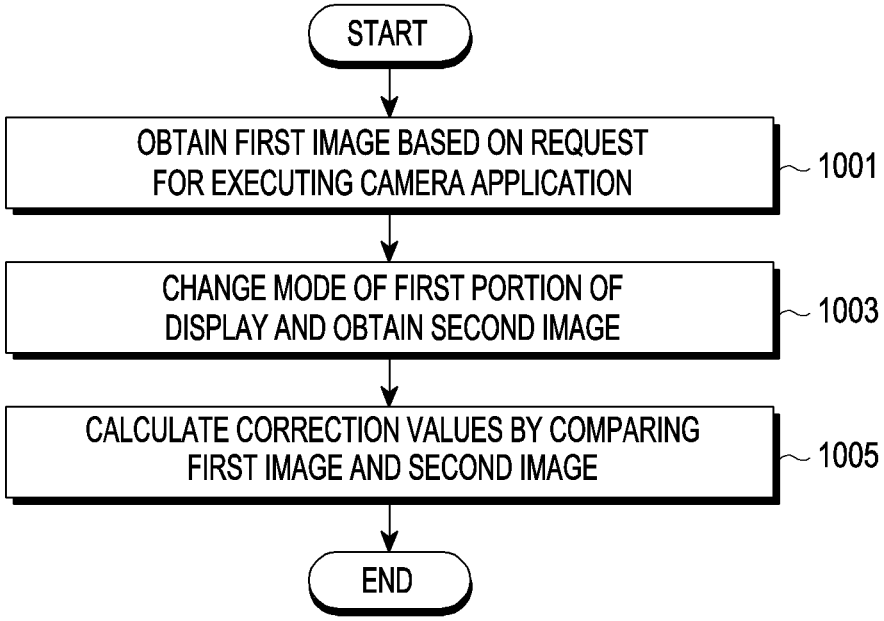

START
OBTAIN FIRST IMAGE BASED ON REQUEST FOR EXECUTING CAMERA APPLICATION
1001
CHANGE MODE OF FIRST PORTION OF DISPLAY AND OBTAIN SECOND IMAGE
1003
CALCULATE CORRECTION VALUES BY COMPARING FIRST IMAGE AND SECOND IMAGE
1005
END

FIG. 10

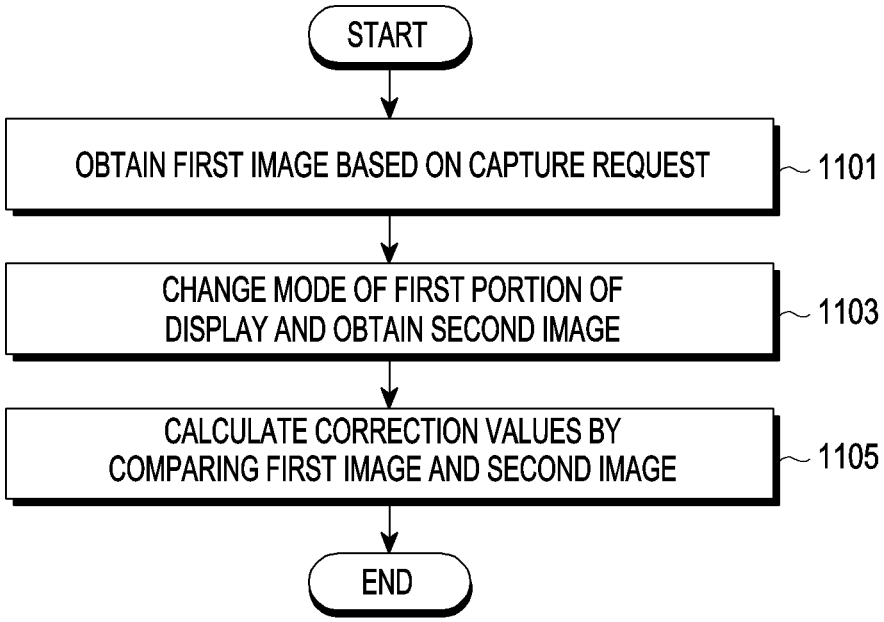

START
OBTAIN FIRST IMAGE BASED ON CAPTURE REQUEST
1101
CHANGE MODE OF FIRST PORTION OF DISPLAY AND OBTAIN SECOND IMAGE
1103
CALCULATE CORRECTION VALUES BY COMPARING FIRST IMAGE AND SECOND IMAGE
1105
END

FIG. 11

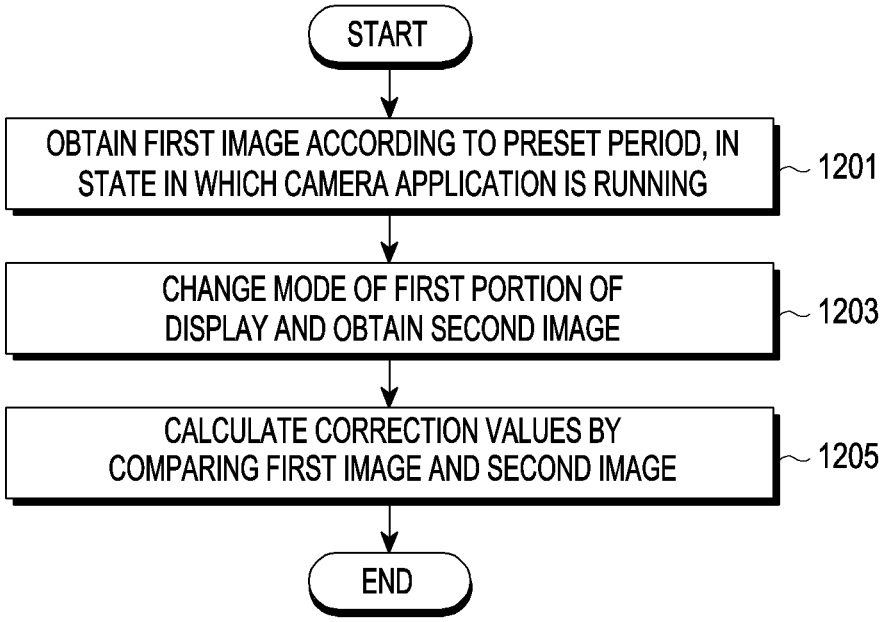

START
OBTAIN FIRST IMAGE ACCORDING TO PRESET PERIOD, IN STATE IN WHICH CAMERA APPLICATION IS RUNNING
1201
CHANGE MODE OF FIRST PORTION OF DISPLAY AND OBTAIN SECOND IMAGE
1203
CALCULATE CORRECTION VALUES BY COMPARING FIRST IMAGE AND SECOND IMAGE
1205
END

FIG. 12

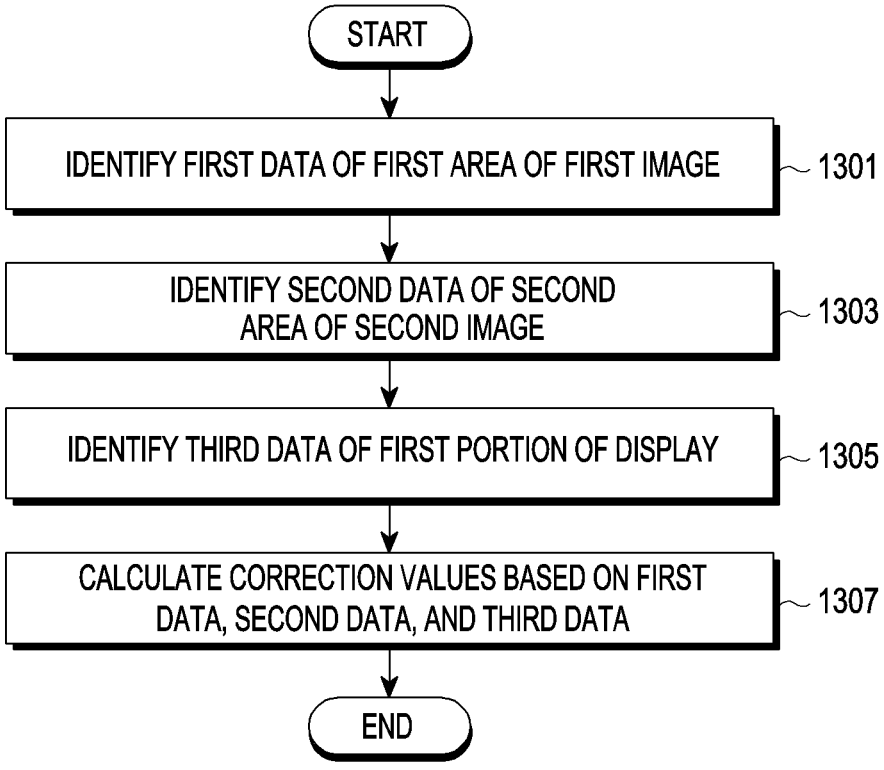

START
IDENTIFY FIRST DATA OF FIRST AREA OF FIRST IMAGE
1301
IDENTIFY SECOND DATA OF SECOND AREA OF SECOND IMAGE
1303
IDENTIFY THIRD DATA OF FIRST PORTION OF DISPLAY
1305
CALCULATE CORRECTION VALUES BASED ON FIRST DATA, SECOND DATA, AND THIRD DATA
1307
END

FIG. 13

METHOD FOR PROVIDING IMAGE AND ELECTRONIC DEVICE SUPPORTING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation application, claiming priority under § 365(c), of an International application No. PCT/KR2022/006268, filed on May 2, 2022, which is based on and claims the benefit of a Korean patent application number 10-2021-0108816, filed on Aug. 18, 2021 and a Korean patent application number 10-2021-0133722, filed on Oct. 8, 2021 in the Korean Intellectual Property Office, the disclosure of which is incorporated by reference herein in its entirety.

BACKGROUND

Technical Field

Certain embodiments of the disclosure relate to a method for providing an image and an electronic device supporting the same.

Description of Related Art

An electronic device, such as a smart phone or a tablet PC may include a camera (or a camera module or a camera device) that may capture a photo or a video.

Disposing the camera under the display may degrade the captured image. For example, as light diffraction or scattering is caused by the display panel, some frequency band components may be attenuated, and resolution may be decreased. Further, if a light source is captured, the flare of the starburst effect may be lost. Further, even in the same light source environment, spectral characteristics for each wavelength are varied due to a difference of the state of the camera. The changing of a camera disposed under the display from the off state to the on state can cause the presence of artifacts in the captured image.

Accordingly, it is desirable to prevent the foregoing.

SUMMARY

According to certain embodiments, an electronic device comprises a display; a camera disposed under the display; and a processor configured to, obtain a first image using the camera in a first state in which a first portion of the display corresponding to a position where the camera is disposed is in a first mode, obtain a second image, using the camera in a second state in which the first portion of the display is in a second mode, calculate correction values, based on first data for a first area of the first image and second data for a second area of the second image, wherein the second area of the second image corresponds to the first area of the first image, and correct at least one image among a plurality of images, using the correction values, wherein one of obtaining the first image and obtaining the second image is responsive to the other of obtaining the first image and the second image.

According to certain embodiments, a method for operating an electronic device including a display and a camera disposed under the display, comprises: obtaining a first image using the camera in a first state in which a first portion of the display corresponding to a position where the camera is disposed is in a first mode, obtaining a second image using the camera in a second state in which the first portion of the display is in a second mode, calculating correction values, based on first data for a first area of the first image and second data for a second area of the second image, wherein the second area of the second image corresponds to the first area of the first image, and correcting at least one image among a plurality of images obtained using the camera, using the correction values, wherein one of obtaining the first image and obtaining the second image is responsive to the other of obtaining the first image and the second image.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating an electronic device in a network environment according to certain embodiments;

FIG. **2** is a block diagram illustrating a camera module according to an embodiment;

FIG. **3** is a view illustrating an electronic device according to certain embodiments;

FIG. **4** is a cross-sectional view illustrating a display and a camera module according to certain embodiments;

FIG. **5** illustrates a pixel structure and a pattern disposed adjacent to a camera module according to certain embodiments;

FIG. **6** is a view illustrating a partial configuration of a display and a camera module according to certain embodiments;

FIG. **7** is a view illustrating operations of an electronic device according to certain embodiments;

FIG. **8** is a view illustrating operations of an electronic device according to certain embodiments;

FIG. **9** is a flowchart illustrating operations of an electronic device according to certain embodiments;

FIG. **10** is a flowchart illustrating operations of an electronic device according to certain embodiments;

FIG. **11** is a flowchart illustrating operations of an electronic device according to certain embodiments;

FIG. **12** is a flowchart illustrating operations of an electronic device according to certain embodiments; and

FIG. **13** is a flowchart illustrating operations of an electronic device according to certain embodiments.

DETAILED DESCRIPTION

According to certain embodiments, a method for providing an image and an electronic device supporting the same may include estimating an external light source using a difference between captured images. The difference between captured images is depends on the state of the under display camera.

Certain embodiments rapidly perform white balancing according to a difference between captured images. The white balancing may be performed using a front camera (e.g., the camera facing in the same direction as the display of the electronic device). Software processing for white balancing and hardware may be also be simplified in accordance with certain embodiments.

FIG. **1** describes an electronic device that includes a camera module **180**. FIG. **2** describes the camera module **180**. FIG. **3** discloses the housing of the electronic device, wherein the camera module is located under the display.

Electronic Device

FIG. **1** is a block diagram illustrating an electronic device in a network environment according to certain embodiments.

Referring to FIG. **1**, the electronic device **101** in the network environment **100** may communicate with an electronic device **102** via a first network **198** (e.g., a short-range wireless communication network), or an electronic device **104** or a server **108** via a second network **199** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **101** may communicate with the electronic device **104** via the server **108**. According to an embodiment, the electronic device **101** may include a processor **120**, memory **130**, an input module **150**, a sound output module **155**, a display module **160**, an audio module **170**, a sensor module **176**, an interface **177**, a connecting terminal **178**, a haptic module **179**, a camera module **180**, a power management module **188**, a battery **189**, a communication module **190**, a subscriber identification module (SIM) **196**, or an antenna module **197**. In some embodiments, at least one (e.g., the connecting terminal **178**) of the components may be omitted from the electronic device **101**, or one or more other components may be added in the electronic device **101**. According to an embodiment, some (e.g., the sensor module **176**, the camera module **180**, or the antenna module **197**) of the components may be integrated into a single component (e.g., the display module **160**).

The processor **120** may execute, for example, software (e.g., a program **140**) to control at least one other component (e.g., a hardware or software component) of the electronic device **101** coupled with the processor **120**, and may perform various data processing or computation. According to one embodiment, as at least part of the data processing or computation, the processor **120** may store a command or data received from another component (e.g., the sensor module **176** or the communication module **190**) in volatile memory **132**, process the command or the data stored in the volatile memory **132**, and store resulting data in non-volatile memory **134**. According to an embodiment, the processor **120** may include a main processor **121** (e.g., a central processing unit (CPU) or an application processor (AP)), or an auxiliary processor **123** (e.g., a graphics processing unit (GPU), a neural processing unit (NPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor **121**. For example, when the electronic device **101** includes the main processor **121** and the auxiliary processor **123**, the auxiliary processor **123** may be configured to use lower power than the main processor **121** or to be specified for a designated function. The auxiliary processor **123** may be implemented as separate from, or as part of the main processor **121**.

The term "processor" as used in this document shall be understood to refer to both the singular and plural contexts.

The auxiliary processor **123** may control at least some of functions or states related to at least one component (e.g., the display module **160**, the sensor module **176**, or the communication module **190**) among the components of the electronic device **101**, instead of the main processor **121** while the main processor **121** is in an inactive (e.g., sleep) state, or together with the main processor **121** while the main processor **121** is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor **123** (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module **180** or the communication module **190**) functionally related to the auxiliary processor **123**. According to an embodiment, the auxiliary processor **123** (e.g., the neural processing unit) may include a hardware structure specified for artificial intelligence model processing. The artificial intelligence model may be generated via machine learning. Such learning may be performed, e.g., by the electronic device **101** where the artificial intelligence is performed or via a separate server (e.g., the server **108**). Learning algorithms may include, but are not limited to, e.g., supervised learning, unsupervised learning, semi-supervised learning, or reinforcement learning. The artificial intelligence model may include a plurality of artificial neural network layers. The artificial neural network may be a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted Boltzmann machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), deep Q-network or a combination of two or more thereof but is not limited thereto. The artificial intelligence model may, additionally or alternatively, include a software structure other than the hardware structure.

The memory **130** may store various data used by at least one component (e.g., the processor **120** or the sensor module **176**) of the electronic device **101**. The various data may include, for example, software (e.g., the program **140**) and input data or output data for a command related thereto. The memory **130** may include the volatile memory **132** or the non-volatile memory **134**.

The program **140** may be stored in the memory **130** as software, and may include, for example, an operating system (OS) **142**, middleware **144**, or an application **146**.

The input module **150** may receive a command or data to be used by other component (e.g., the processor **120**) of the electronic device **101**, from the outside (e.g., a user) of the electronic device **101**. The input module **150** may include, for example, a microphone, a mouse, a keyboard, keys (e.g., buttons), or a digital pen (e.g., a stylus pen).

The sound output module **155** may output sound signals to the outside of the electronic device **101**. The sound output module **155** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record. The receiver may be used for receiving incoming calls. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

The display module **160** may visually provide information to the outside (e.g., a user) of the electronic device **101**. The display **160** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display **160** may include a touch sensor configured to detect a touch, or a pressure sensor configured to measure the intensity of a force generated by the touch.

The audio module **170** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **170** may obtain the sound via the input module **150**, or output the sound via the sound output module **155** or a headphone of an external electronic device (e.g., an electronic device **102**) directly (e.g., wiredly) or wirelessly coupled with the electronic device **101**.

The sensor module **176** may detect an operational state (e.g., power or temperature) of the electronic device **101** or an environmental state (e.g., a state of a user) external to the electronic device **101**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **176** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

The interface **177** may support one or more specified protocols to be used for the electronic device **101** to be coupled with the external electronic device (e.g., the electronic device **102**) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface **177** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

A connecting terminal **178** may include a connector via which the electronic device **101** may be physically connected with the external electronic device (e.g., the electronic device **102**). According to an embodiment, the connecting terminal **178** may include, for example, a HDMI connector, a USB connector, a SD card connector, or an audio connector (e.g., a headphone connector).

The haptic module **179** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or motion) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **179** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

The camera module **180** may capture a still image or moving images. According to an embodiment, the camera module **180** may include one or more lenses, image sensors, image signal processors, or flashes.

The power management module **188** may manage power supplied to the electronic device **101**. According to one embodiment, the power management module **188** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

The battery **189** may supply power to at least one component of the electronic device **101**. According to an embodiment, the battery **189** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

The communication module **190** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **101** and the external electronic device (e.g., the electronic device **102**, the electronic device **104**, or the server **108**) and performing communication via the established communication channel. The communication module **190** may include one or more communication processors that are operable independently from the processor **120** (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **190** may include a wireless communication module **192** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **194** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device **104** via a first network **198** (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or a second network **199** (e.g., a long-range communication network, such as a legacy cellular network, a 5G network, a next-generation communication network, the Internet, or a computer network (e.g., local area network (LAN) or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **192** may identify or authenticate the electronic device **101** in a communication network, such as the first network **198** or the second network **199**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module **196**.

The wireless communication module **192** may support a 5G network, after a 4G network, and next-generation communication technology, e.g., new radio (NR) access technology. The NR access technology may support enhanced mobile broadband (eMBB), massive machine type communications (mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module **192** may support a high-frequency band (e.g., the mmWave band) to achieve, e.g., a high data transmission rate. The wireless communication module **192** may support various technologies for securing performance on a high-frequency band, such as, e.g., beamforming, massive multiple-input and multiple-output (massive MIMO), full dimensional MIMO (FD-MIMO), array antenna, analog beam-forming, or large scale antenna. The wireless communication module **192** may support various requirements specified in the electronic device **101**, an external electronic device (e.g., the electronic device **104**), or a network system (e.g., the second network **199**). According to an embodiment, the wireless communication module **192** may support a peak data rate (e.g., 20 Gbps or more) for implementing eMBB, loss coverage (e.g., 164 dB or less) for implementing mMTC, or U-plane latency (e.g., 0.5 ms or less for each of downlink (DL) and uplink (UL), or a round trip of 1 ms or less) for implementing URLLC.

The antenna module **197** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device). According to an embodiment, the antenna module **197** may include one antenna including a radiator formed of a conductor or conductive pattern formed on a substrate (e.g., a printed circuit board (PCB)). According to an embodiment, the antenna module **197** may include a plurality of antennas (e.g., an antenna array). In this case, at least one antenna appropriate for a communication scheme used in a communication network, such as the first network **198** or the second network **199**, may be selected from the plurality of antennas by, e.g., the communication module **190**. The signal or the power may then be transmitted or received between the communication module **190** and the external electronic device via the selected at least one antenna. According to an embodiment, other parts (e.g., radio frequency integrated circuit (RFIC)) than the radiator may be further formed as part of the antenna module **197**.

According to certain embodiments, the antenna module **197** may form a mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, a RFIC disposed on a first surface (e.g., the bottom surface) of the printed circuit board, or adjacent to the first surface and capable of supporting a designated high-frequency band (e.g., the mmWave band), and a plurality of antennas (e.g., array antennas) disposed on a second surface (e.g., the top or a side surface) of the printed circuit board, or adjacent to the second surface and capable of transmitting or receiving signals of the designated high-frequency band.

At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

According to an embodiment, commands or data may be transmitted or received between the electronic device **101** and the external electronic device **104** via the server **108** coupled with the second network **199**. The external electronic devices **102** or **104** each may be a device of the same or a different type from the electronic device **101**. According to an embodiment, all or some of operations to be executed at the electronic device **101** may be executed at one or more of the external electronic devices **102**, **104**, or **108**. For example, if the electronic device **101** should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **101**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device **101**. The electronic device **101** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device **101** may provide ultra low-latency services using, e.g., distributed computing or mobile edge computing. In another embodiment, the external electronic device **104** may include an Internet-of-things (IoT) device. The server **108** may be an intelligent server using machine learning and/or a neural network. According to an embodiment, the external electronic device **104** or the server **108** may be included in the second network **199**. The electronic device **101** may be applied to intelligent services (e.g., smart home, smart city, smart car, or health-care) based on 5G communication technology or IoT-related technology.

The electronic device **101** can include a camera module **180** that is configured to capture an image or video of the scene in the vicinity of the electronic device **101**. FIG. **2** describes the camera module **180**.

Camera Module

FIG. **2** is a block diagram illustrating a camera module according to an embodiment; Referring to FIG. **2**, the camera module **180** may include a lens assembly **210**, a flash **220**, an image sensor **230**, an image stabilizer **240**, memory **250** (e.g., buffer memory), or an image signal processor **260**. The lens assembly **210** may collect light emitted or reflected from an object whose image is to be taken. The lens assembly **210** may include one or more lenses. According to an embodiment, the camera module **180** may include a plurality of lens assemblies **210**. In such a case, the camera module **180** may form, for example, a dual camera, a 360-degree camera, or a spherical camera. Some of the plurality of lens assemblies **210** may have the same lens attribute (e.g., field of view, focal length, auto-focusing, f number, or optical zoom), or at least one lens assembly may have one or more lens attributes different from those of another lens assembly. The lens assembly **210** may include, for example, a wide-angle lens or a telephoto lens.

The flash **220** may emit light that is used to reinforce light reflected from an object. According to an embodiment, the flash **220** may include one or more light emitting diodes (LEDs) (e.g., a red-green-blue (RGB) LED, a white LED, an infrared (IR) LED, or an ultraviolet (UV) LED) or a xenon lamp. The image sensor **230** may obtain an image corresponding to an object by converting light emitted or reflected from the object and transmitted via the lens assembly **210** into an electrical signal. According to an embodiment, the image sensor **230** may include one selected from image sensors having different attributes, such as a RGB sensor, a black-and-white (BW) sensor, an IR sensor, or a UV sensor, a plurality of image sensors having the same attribute, or a plurality of image sensors having different attributes. Each image sensor included in the image sensor **230** may be implemented using, for example, a charged coupled device (CCD) sensor or a complementary metal oxide semiconductor (CMOS) sensor.

The image stabilizer **240** may move the image sensor **230** or at least one lens included in the lens assembly **210** in a particular direction, or control an operational attribute (e.g., adjust the read-out timing) of the image sensor **230** in response to the movement of the camera module **180** or the electronic device **101** including the camera module **180**. This allows compensating for at least part of a negative effect (e.g., image blurring) by the movement on an image being captured. According to an embodiment, the image stabilizer **240** may sense such a movement by the camera module **180** or the electronic device **101** using a gyro sensor (not shown) or an acceleration sensor (not shown) disposed inside or outside the camera module **180**. According to an embodiment, the image stabilizer **240** may be implemented, for example, as an optical image stabilizer. The memory **250** may store, at least temporarily, at least part of an image obtained via the image sensor **230** for a subsequent image processing task. For example, if image capturing is delayed due to shutter lag or multiple images are quickly captured, a raw image obtained (e.g., a Bayer-patterned image, a high-resolution image) may be stored in the memory **250**, and its corresponding copy image (e.g., a low-resolution image) may be previewed via the display module **160**. Thereafter, if a specified condition is met (e.g., by a user's input or system command), at least part of the raw image stored in the memory **250** may be obtained and processed, for example, by the image signal processor **260**. According to an embodiment, the memory **250** may be configured as at least part of the memory **130** or as a separate memory that is operated independently from the memory **130**.

The image signal processor **260** may perform one or more image processing with respect to an image obtained via the image sensor **230** or an image stored in the memory **250**. The one or more image processing may include, for example, depth map generation, three-dimensional (3D) modeling, panorama generation, feature point extraction, image synthesizing, or image compensation (e.g., noise reduction, resolution adjustment, brightness adjustment, blurring, sharpening, or softening). Additionally or alternatively, the image signal processor **260** may perform control (e.g., exposure time control or read-out timing control) with respect to at least one (e.g., the image sensor **230**) of the components included in the camera module **180**. An image processed by the image signal processor **260** may be stored back in the memory **250** for further processing, or may be provided to an external component (e.g., the memory **130**, the display module **160**, the electronic device **102**, the electronic device **104**, or the server **108**) outside the camera module **180**. According to an embodiment, the image signal processor **260** may be configured as at least part of the processor **120**, or as a separate processor that is operated independently from the processor **120**. If the image signal processor **260** is configured as a separate processor from the processor **120**, at least one image processed by the image signal processor **260** may be displayed, by the processor **120**, via the display module **160** as it is or after being further processed.

According to an embodiment, the electronic device **101** may include a plurality of camera modules **180** having different attributes or functions. In such a case, at least one of the plurality of camera modules **180** may form, for example, a wide-angle camera and at least another of the plurality of camera modules **180** may form a telephoto camera. Similarly, at least one of the plurality of camera modules **180** may form, for example, a front camera and at least another of the plurality of camera modules **180** may form a rear camera.

The lens assembly **210** is typically exposed through a surface of the housing in order to be able to capture an image or video of the area proximate to the electronic device. However, exposure of lens assembly **210** to the surface may reduce the display area of the display module **160**. Accordingly, to increase the display area, the camera module and lens assembly **210** may be disposed below the display. FIG. **3** discloses an electronic device **101** with an under display camera.

Under Display Camera

FIG. **3** is a view illustrating an electronic device according to certain embodiments, wherein the camera module **330** may be disposed under the display **320**.

Disposing the camera under the display may degrade the captured image. For example, as light diffraction or scattering is caused by the display panel, some frequency band components may be attenuated, and resolution may be decreased. Further, if a light source is captured, the flare of the starburst effect may be lost. Further, even in the same light source environment, spectral characteristics for each wavelength are varied due to a difference of the state of the camera. The changing of a camera disposed under the display from the off state to the on state can cause the presence of artifacts in the captured image.

According to certain embodiments, the foregoing may be alleviated, if not prevented or eliminated.

Referring to FIG. **3**, according to certain embodiments, an electronic device **301** (e.g., the electronic device **101** of FIG. **1**) may include a body unit **310**, a display **320** (e.g., the display module **160** of FIG. **1**), and a camera module **330** (e.g., the camera module **180** of FIG. **1** or **2**). Although FIG. **3** illustrates an example in which one camera module is included, embodiments are not limited thereto.

The body unit (or housing) **310** may include various components necessary for operation of the electronic device **301**. For example, the body unit **310** may include various components, such as a board (e.g., a printed circuit board (PCB), a flexible PCB (FPCB), or a rigid-flexible PCB (RFPCB)), a processor (e.g., the processor **120** of FIG. **1**), a memory (e.g., the memory **130** of FIG. **1**), or a communication module (e.g., the communication module **190** of FIG. **1**).

The display **320** may be disposed on a first surface (e.g., front surface) of the body unit **310**, and the camera module **330** may be disposed to face the first surface. For example, the camera module **330** may not be visually exposed, and may be a under display camera (UDC).

Although FIG. **3** illustrates an example in which the camera module **330** is disposed to face the first surface (e.g., front surface, a surface where the display **320** is primarily disposed) of the body unit **310**, embodiments are not limited thereto. For example, the display **320**, in certain embodiments, may extend to a second surface (e.g., rear surface) of the body unit **310**, and the camera module **330** may be disposed to face the second surface (e.g., rear surface) of the body unit **310**.

The display **320** may display various contents, such as text or images. The display **320** may be composed of a plurality of layers. For example, the display **320** may have a structure in which a window layer, a touchscreen panel, a display panel, and/or a protection layer are sequentially stacked (see FIG. **4**).

The display **320** may transmit external light in at least a partial area where the camera module **330** is disposed. For example, the display **320** may transmit external light through an empty space between the pixels included in the display **320**. The camera module **330** may capture an image using the external light introduced through the display **320**.

The camera module **330** may be mounted in an area where at least some layers included in the display **320** have been removed. For example, a layer (e.g., a shielding layer) through which external light may not be transmitted may be removed, and the lens unit (e.g., the lens unit **331** of FIG. **4**) of the camera module **330** may be disposed in the removed area.

A patterned metal layer (hereinafter, pattern layer) may be disposed on the front surface of the lens unit (e.g., the lens unit **331** of FIG. **4**) of the camera module **330**. For example, the pattern layer (e.g., the pattern layer **410** of FIG. **4**) may be a layer constituting the display **320** and be disposed between the pixels of the display panel and the lens unit (see FIGS. **5** and **6**).

FIG. **4** is a cross-sectional view illustrating a display and a camera module according to certain embodiments. The camera module of FIG. **4** may be the camera module **330** of FIG. **3**. The display of FIG. **4** may be the display **320** of FIG. **3**. FIG. **4** is exemplary but embodiments are not limited thereto. The camera module **330** is disposed under the display panel **403**.

Referring to FIG. **4**, a display (e.g., the display **320** of FIG. **3**) may include a window layer **401**, a display panel **403**, and a protection layer (or shielding layer or back cover) **480**. The display panel **403** may include a base layer **405**, a pattern layer **410** stacked on the base layer **405**. A wiring layer **420** may be stacked on the pattern layer **410**. A light emitting layer **430** may be stacked on the wiring layer. An encapsulation layer **440** may be stacked on the light emitting layer **430**. The blocking portion **415** blocks light emitted from the pixel **431** from entering the camera module **330**.

The protection layer **480** may be formed under the entire display panel **403**, except an area that corresponds to the location of the camera module **330**. The pattern layer **410** that corresponds to the open area may include blocking portions **415** that correspond to pixels **431** of the light emitting layer **430**. However, openings **416** that are between the block portions **415** allow light from the exterior to enter the camera module **330**. The window layer (e.g., ultra-thin glass (UTG)) **401** may include a polymer. In this case, the window layer **401** may include polyethylene terephthalate (PET) or polyimide (PI). In certain embodiments, a plurality of window layers **401** may be disposed.

Although not shown in FIG. **4**, the display may further include a touch panel (touch sensor) between the window layer **401** and the display panel **403**.

The display may include a control circuit (not shown). For example, the control circuit (not shown) may include a display driver IC (DDI) and/or a touch display driver IC (TDDI) disposed in a chip on panel (COP) or chip on film (COF) type.

The electronic device **301** may include a plurality of displays (e.g., first and second displays), and at least one of the plurality of displays may include a flexible characteristic. For example, in the electronic device **301**, the first

display (e.g., the display **320**) may include an on cell touch AMOLED (OCTA) display, and the second display (e.g., a flexible display) may include an unbreakable (UB)-type active matrix organic light-emitting diode (OLED) display.

The display panel **403** may include a base layer **405**, a pattern layer **410**, a wiring layer **420**, a light emitting layer (or organic material layer) **430**, and an encapsulation layer (or protection layer) **440**. Although not shown in FIG. **2**, the display panel **403** may further include a polarization layer (polarizer) (e.g., a polarization film), an adhesive layer, and a touch panel. For example, the adhesive layer, as an adhesive member (e.g., optical clear adhesive (OCA) or pressure sensitive adhesive (PSA)), may be disposed between the layers.

A base layer **405** may be formed in a lower direction (e.g., a direction toward the camera module **330**) of the pattern layer **410**. For example, the wiring layer **420** and the light emitting layer **430** may be stacked on the base layer **405**. According to certain embodiments, the base layer **405** may include a transparent insulation substrate (e.g., a substrate). For example, the base layer **405** may be formed of a glass substrate, a quartz substrate, or a transparent resin substrate. For example, the transparent resin substrate may include a polyimide-based resin, an acryl-based resin, a polyacrylate-based resin, a polycarbonate-based resin, a polyether-based resin, a sulfonic acid-based resin, and/or a polyethylene terephthalate-based resin.

The pattern layer (or bottom metal layer (BML)) **410** may form a pattern in the area where at least a portion of the protection layer (or shielding layer or back cover) **480** has been removed to dispose the camera module **330**. The pattern layer **410** may include a blocking portion (or blocking area) **415** and an opening (or an open area) **416**. The blocking portion **415** may be an area at least partially corresponding to the pixel **431** of the light emitting layer (organic layer) **430**, and the opening **416** may be an area at least partially corresponding to the panel opening between the pixels **431** of the light emitting layer (organic layer) **430**. According to an embodiment, the pattern layer **410** may be formed of a metal material and be formed under the wiring layer **420** by deposition and/or patterning. The pattern layer **410** may protect the pixel **431** of the light emitting layer (organic layer) **430** and block the light generated from the pixel **431**. According to certain embodiments, the pattern layer **410** may include a designated pattern (black matrix) or an opaque metal layer (e.g., buffer layer) including designated patterns, to reduce diffraction of the light introduced to the camera module **330**.

The external light transmitted through the opening **416** may be introduced to the lens unit **331**. For example, light may be diffracted or scattered depending on the shape or size of the opening **416**.

The wiring layer **420** and the light emitting layer **430** may be formed by depositing a light emitting element (e.g., organic electroluminescence (EL)) on a thin film transistor (TFT) substrate. According to certain embodiments, the light emitting layer **430** may include a plurality of pixels **431** in which a plurality of subpixels (e.g., red, green, and blue) constitute one pixel. According to certain embodiments, the display panel **403** may include an active area (e.g., a display area) and an inactive area (e.g., a non-display area). For example, the active area may correspond to an area in which the plurality of pixels **431** are disposed, and the inactive area may be disposed outside the active area and correspond to the bezel area of the display panel **403**.

The wiring layer **420** may include a TFT element for driving each pixel of the active area, a metal wiring, or an insulation film. According to certain embodiments, the wiring layer **420** may include a liquid crystal polymer (LCP), low temperature polycrystalline silicon (LTPS), or low temperature polycrystalline oxide (LTPO) glass, and the plurality of pixels may include thin film transistors (TFTs) formed on the LTPS glass.

The light emitting layer **430** may include a light emitting element (e.g., organic EL). Organic EL may generate light when holes and electrons are injected from a positive electrode (cathode) and a negative electrode (anode).

When the display panel **403** is viewed from above the first surface (e.g., front surface), in an area at least partially overlapping at least one component (e.g., the camera module **330** or a sensor module (e.g., the sensor module **176** of FIG. **1**)) included in the electronic device **301**, the plurality of pixels may not be disposed or a plurality of pixels with a lower arrangement density than the non-overlapping area may be included.

The encapsulation layer **440** (e.g., thin film encapsulation (TFE)) may be a layer in which organic materials and inorganic materials are alternately formed on the light emitting layer **430** to protect the light emitting element from oxygen or moisture. For example, the encapsulation layer **440** may be a pixel protection layer to protect the plurality of pixels **431**. For example, the encapsulation layer **440** may include an encapsulation glass.

The protection layer (or shielding layer) **480** may support and protect the display panel **403**. The protection layer **480** may block light or electromagnetic waves, introduced from the display panel **403**, from entering the electronic device **301**. The protection layer **480** may include a black film and a metal (e.g., copper) plate. For example, the protection layer **480** may be disposed under the display panel **403**, thereby providing a dark background for securing the visibility of the display panel **403**. The protection layer **480** may be formed of a shock absorbing member (e.g., cushion) for cushioning. For example, the protection layer **480** may include an opaque metal layer (e.g., a black layer including an uneven pattern) for blocking light incident from the outside or light generated by the display panel **403** and removing air bubbles that may build up between the display panel **403** and its underneath attachments and/or a cushioning layer (e.g., a sponge layer) disposed to mitigate shocks.

The protection layer **480** may include a heat dissipation member (e.g., a graphite sheet) for heat dissipation and/or a conductive member (e.g., a metal plate). For example, the conductive member may help to reinforce the rigidity of the electronic device **301**, shield ambient noise, and dissipate the heat radiated from the ambient heat radiating components.

The protection layer **480** may be at least partially open, and the lens unit **331** may be disposed in the open area. In the area where the protection layer **480** has been removed, the pattern of the pattern layer **410** may be formed.

Referring to FIG. **4**, according to certain embodiments, the light emitted from an external light source and transmitted through a portion (e.g., the first portion **499**) of the display **320** (e.g., the display panel **403**) may reach the lens unit **331** and be used for image capturing. For example, the first portion **499** of the display **320** (e.g., the display panel **403**) may mean an area corresponding to the area in which the camera module **330** (e.g., the lens unit **331**) is disposed in the display panel **403**. For example, the electronic device **301** may obtain an image using the light emitted from the light source and introduced through the first portion **499** of the display panel **403**.

The electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may control a portion (e.g., the first portion **499**) of the display **320**. For example, 'electronic device **301** controls the first portion **499** of the display **320**' may mean controlling at least a partial area of the light emitting layer **430** and/or the wiring layer **420** of the display panel **403**, included in the first portion **499**. For example, 'electronic device **301** controls the first portion **499** of the display **320**' may mean controlling at least one pixel (e.g., the pixel **431**) included in the first portion **499** among the plurality of pixels (e.g., pixel **431**) of the electronic device **301**. For example, the electronic device **301** may control the first portion **499** of the display **320** to display a screen in the first portion **499** of the display **320**. The state in which a screen is displayed in the first portion **499** of the display **320** may be referred to as an active state (or under display camera (UDC)-On state). For example, in the state in which the first portion **499** of the display **320** is active (e.g., the UDC-On state), the electronic device **301** may obtain an image using the camera module **330**. As another example, the electronic device **301** may control the first portion **499** of the display **320** to display no screen in the first portion **499** of the display **320**. The state in which no screen is displayed in the first portion **499** of the display **320** may be referred to as an inactive state (or under display camera (UDC)-Off state). For example, in the state in which the first portion **499** of the display **320** is inactive (e.g., the UDC-Off state), the electronic device **301** may obtain an image using the camera module **330**.

FIG. **5** illustrates a pixel structure and a pattern disposed adjacent to a camera module according to certain embodiments.

The light emitting layer **430** may include pixel areas **435** and panel openings **436**. The pixel areas **435** are areas where the pixels are disposed. The panel openings **436** are areas between the pixel areas **435**. On the display, the blocking portions **515** are disposed to be directly under the pixel areas **435** in the area that corresponds to the camera module **330**. Accordingly, light from the pixels is blocked by the blocking portions **515**, while light passes through the panel openings **436**.

Referring to FIG. **5**, according to certain embodiments, the light emitting layer **430** may include pixel areas **435** in which pixels is disposed and panel openings **436**. The pixel area **435** may be areas having pixels configured as light emitting elements (e.g., organic electro luminescence (EL)). The panel opening **436** may be empty spaces between pixel areas **435**. The panel openings **436** may have various shapes. For example, panel openings **436** may be cross-shaped polygons. As another example, the panel openings **436** may have rectangular shapes, but are not limited to a specific shape. The panel opening **436** may transmit or permit the light introduced from the outside, and the transmitted light may reach the lens unit **331** and be used for image capturing.

A pattern portion **510** of the pattern layer **410** may include a blocking portion **515** and an opening **516**. The blocking portion **515** may be an area corresponding to the pixel area **435**, and the opening **516** may be an area corresponding to the panel opening **436**.

The blocking portion **515** may prevent the light generated from the pixel area **435** from entering the lens unit **331**. The opening **516** may transmit the light transmitted through the panel opening **436**.

The blocking portions **515** may have substantially the same shapes and sizes as the pixel areas **435**. For example, the blocking portions **515** and the pixel areas **435** may have rectangular shapes in substantially the same size. According to another embodiment, the blocking portions **515** may have substantially the same shapes as, but different sizes from, the pixel areas **435**. For example, the blocking portions **515** and the pixel areas **435** may have rectangular shapes, and the sizes of the blocking portions **515** may be larger than the sizes of the pixel areas **435**. According to another embodiment, the blocking portions **515** may have a different shape from the pixel areas **435**, and the blocking portions **515** and the pixel areas **435** are not limited in shape.

The openings **516** may have substantially the same shapes and sizes as the panel openings **436**. For example, the opening **516** and the panel opening **436** may be cross-shaped polygons in substantially the same size. According to another embodiment, the opening **516** may have substantially the same shape as, but a different size from, the panel opening **436**. For example, the opening **516** and the panel opening **436** may be cross-shaped polygons, and the size of the opening **516** may be smaller than the size of the panel opening **436**. According to another embodiment, the opening **516** may have a different shape from the panel opening **436**, but the opening **516** and the panel opening **436** are not limited in shape.

According to certain embodiments, the blocking portions **515** and the openings **516** may be disposed on the front surface of the lens unit **331**. The light transmitted through the panel openings **436** and the openings **516** may reach the lens unit **331** and be used for image capturing.

FIG. **6** is a view illustrating a partial configuration of a display and a camera module according to certain embodiments. FIG. **6** is described with reference to FIGS. **7** and **8**. FIG. **7** is a view illustrating operations of an electronic device according to certain embodiments. FIG. **8** is a view illustrating operations of an electronic device according to certain embodiments.

The first portion **499**, the portion of the display that is disposed over the camera module **330** blocks light from the pixels from entering the lens assembly **331**, while permitting light through the panel openings **436**.

Referring to FIG. **6**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may control the lens unit **331** of the camera module **330**, the image sensor **332**, and/or a portion (e.g., the first portion **499**) of the display **320** (e.g., the display panel **403**) to obtain an image. For example, the electronic device **301** may control the first portion **499** of the display **320** to display a screen in the first portion **499** of the display **320** (e.g., active state or UDC-On state) or to display no screen (e.g., inactive state or UDC-Off state). For example, the camera module **330** may collect the light transmitted through the first portion **499**, through the lens unit **331** in the UDC-On state or UDC-Off state. The image sensor **332** may convert the light collected through the lens unit **331** into an electrical signal.

Referring to FIG. **7**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may display a first screen **700** using the display **320**. For example, the electronic device **301** may control at least one pixel among the plurality of pixels included in the display panel **403** to display a screen.

The first screen **700** may include a first portion **710** that corresponds to the location of the camera module **300**. In the UDC-On state, (a) of FIG. **7**, the first portion **710** displays content. In the UDC-Off state, (b) of FIG. **7**, the first portion **710** does not display content, thereby resulting in an empty content area above the camera module **330**.

In (a) and (b) of FIG. **7**, a first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320** may be a portion corresponding to the position in which the camera module **330** is disposed, which has been described above in connection with the first portion **499** of FIG. **4**.

Referring to (a) of FIG. **7**, the electronic device **301** may display the first screen **700** using the display **320**. For example, the electronic device **301** may display a first partial screen **720**, as a partial area of the first screen **700**, in the first portion **710** (e.g., the first portion **499** of FIG. **4**). The "partial screen" may mean a screen displayed in the first portion **710** of the display **320** of the electronic device **301**. For example, the first partial screen **720** may form a portion of the first screen **700**. For example, the first screen **700** may include the first partial screen **720**. For example, the first partial screen **720** and the first screen **700** overall may form one screen, and the border between the first partial screen **720** and the first screen **700** may be imperceptible with the naked eye. In (a) of FIG. **7**, the state in which a partial screen (e.g., the first partial screen **720**) is displayed in the first portion **710** of the display **320** may mean the above-described UDC-On state. It is noted that in (a) of FIG. **7**, the first portion **710** is drawing dimmer to allow the reader to more easily discern the first portion **710**. However, the dimmer drawing shall not be understood to suggest that the content on the display is dimmer.

Referring to (b) of FIG. **7**, the electronic device **301** may display the first screen **700** using the display **320**. For example, the electronic device **301** may control the first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320** to display no screen in the first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320**. For example, the electronic device **301** may display a first screen **700** using the display **320** and may display no screen in the first portion **710** of the display **320**. Or, the electronic device **301** may control the display **320** to display no screen in the entire area of the display **320**. The state **730** in which no screen is displayed in the first portion **710** of the display **320** may mean the above-described UDC-Off state. (b) of FIG. **7** discloses an embodiment in which in the state in which no screen is displayed in the first portion **710** of the display **320**, the camera module **330** disposed under the display **320** is identified with the naked eye through the first portion **710** of the display **320**. However, this is merely an example, and the display **320** may be implemented so that the camera module **330** disposed under the display **320** is not identified with the naked eye even in the state in which no screen is displayed in the first portion **710** of the display **320**.

In certain embodiments, in the UDC-off state, the first portion **710** may have less brightness or luminance as compared to the UDC-on state.

Referring to FIG. **8**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may display a first screen **800** using the display **320**. According to certain embodiments, the electronic device **301** may control the first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320** to display a screen, or no screen, in the first portion **710** of the display **320**.

For example, (a) of FIG. **8** illustrates an embodiment (**801**) in which the electronic device **301** displays no screen in the first portion **710** of the display **320**.

As another example, (b) of FIG. **8** illustrates an embodiment (**802**) in which the electronic device **301** displays a first partial screen (e.g., a white screen) in the first portion **710** of the display **320**.

As another example, (c) of FIG. **8** illustrates an embodiment (**803**) in which a second partial screen (e.g., a red screen) in the first portion **710** of the display **320**.

As another example, (d) of FIG. **8** illustrates an embodiment (**804**) in which a third partial screen (e.g., a green screen) in the first portion **710** of the display **320**.

As another example, (e) of FIG. **8** illustrates an embodiment (**805**) in which a fourth partial screen (e.g., a blue screen) in the first portion **710** of the display **320**.

According to an embodiment, the electronic device **301** may change the mode of the first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320**. The mode of the first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320** may mean a state in which no screen is displayed in the first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320**, or a partial screen (e.g., the first partial screen, the second partial screen, the third partial screen, or the fourth partial screen) is displayed in the first portion **710** (e.g., the first portion **499** of FIG. **4**) of the display **320**. For example, the electronic device **301** may change a first mode in which no screen is displayed in the first portion **710** of the display **320** into a second mode in which the first partial screen (e.g., a white screen) is displayed in the first portion **710**. As another example, the electronic device **301** may change a first mode in which the first partial screen (e.g., a white screen) is displayed in the first portion **710** of the display **320** into a second mode in which the second partial screen (e.g., a red screen) is displayed in the first portion **710**.

FIG. **8** is a view illustrating the electronic device **301** is able to display no screen in the first portion **710** of the display **320** ((a) of FIG. **8**) or to display various partial screens. It will be appreciated by one of ordinary skill in the art that the screen which may be displayed in the first portion **710** of the display **320** is not limited to the example disclosed in FIG. **8**.

FIG. **9** is a flowchart illustrating operations of an electronic device according to certain embodiments. FIG. **9** is described with reference to FIGS. **4** and **7**.

Referring to FIG. **9**, in operation **901**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may obtain a first image using the camera module **180** in a first state in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display **320** is in the first mode. For example, in the first state, the first portion of the display **320** may be in the UDC-On state as shown in (a) of FIG. **7**.

In operation **903**, according to certain embodiments, the electronic device **301** may obtain a second image using the camera module **180** in a second state in which the first portion (e.g., **499** or **710**) of the display **320** is in the second mode. For example, after obtaining the first image using the camera module **180** in the first state in which no screen is displayed in the first portion (e.g., **499** or **710**) of the display **320**, the electronic device **301** may obtain the second image using the camera module **180** in the second state in which a partial screen (e.g., one screen of a white screen, a red screen, a green screen, or a blue screen) is displayed in the first portion (e.g., **499** or **710**) of the display **320**. For example, in the second state, the first portion of the display **320** may be in the UDC-off state as shown in (b) of FIG. **7**, or any of the states of FIG. **8**. As another example, after obtaining the first image using the camera module **180** in the first state in which a partial screen (e.g., one screen of a white screen, a red screen, a green screen, or a blue screen, or a screen in which the left semi circle is in a first color

(e.g., blue) and the right circle is in a second color (e.g., red)) is displayed in the first portion (e.g., **499** or **710**) of the display **320**, the electronic device **301** may obtain the second image using the camera module **180** in the second state in which another partial screen (e.g., one screen of a white screen, a red screen, a green screen, or a blue screen) is displayed in the first portion (e.g., **499** or **710**) of the display **320**. The method of configuring the partial screens is exemplary, and the type of the partial screen is not limited.

In certain embodiments, the first image and the second image may be captured contemporaneously with each other. For example, the second image may be captured in response to capturing the first image. In certain embodiments, the first image and the second image may be captured within a time frame, such that an image captured of the scene that is proximate to the electronic device **101** is not expected to be perceptibly different. In certain embodiments, the first image and the second image may be captured within 1 second of each other. In certain embodiments, the first image and the second image may be captured within 3 seconds of each other.

In operation **905**, according to certain embodiments, the electronic device **301** may calculate correction values based on the first image obtained in the first state and the second image obtained in the second state. For example, the electronic device **301** may calculate the correction values by comparing the first image and the second image. That the electronic device **301** compares the first image and the second image may mean comparing data of at least a partial area (e.g., the entire area or a partial area) of the first image and data of at least a partial area of the second image. For example, the electronic device **301** may compare the data of the first area of the first image and the data of the second area of the second image corresponding to the first area of the first image. For example, the electronic device **301** may compare the data of the same areas (or corresponding areas) (e.g., center areas, first quadrant areas, or upper areas) in the first image and the second image, and the method of configuring the areas used for data comparison is not limited. For example, the electronic device **301** may compare the data of the center area of the first image and the data of the center area of the second image. For example, the data of the partial area of the image may include the red (R) level, green (G) level, and blue (B) level of the partial area of the image. For example, the electronic device **301** may compare the R level, G level, and B level of the first area of the first image and the R level, G level, and B level of the second area of the second image corresponding to the first area of the first image. For example, the electronic device **301** may calculate the correction values (e.g., gain used for white balancing) based on the data of the first area of the first image and the data of the second area of the second image corresponding to the first area of the first image. For example, the electronic device **301** may compare the R level, G level, and B level of the first area (e.g., center area) of the first image and the R level, G level, and B level of the second area (e.g., center area) of the second image corresponding to the first area of the first image, calculating the gain (e.g., R gain, G gain, and/or B gain) used for white balancing. The method of calculating the correction values using the first data of the first image and the second data of the second image by the electronic device **301** and the type of data and correction values are not limited.

According to an embodiment, the electronic device **301** may extract data corresponding to any color (e.g., gray) from one input image (e.g., the first image or the second image) and calculate the gain for equally adjusting the R level, G level, and B level of the extracted data. For example, it is possible to perform white balancing by extracting the data corresponding any color (e.g., gray) of the entire area of one input image (e.g., first image or second image) using a light source estimation scheme and/or a gray detection scheme.

According to an embodiment, the electronic device **301** may also calculate the gain for equally adjusting the R level, G level, and B level for the area corresponding to gray, under the assumption that data corresponding to gray is present in one input image (e.g., first image or second image). For example, the electronic device **301** may also calculate the gain for equally adjusting the R level, G level, and B level for the area corresponding to gray by analyzing one input image (e.g., first image or second image) captured for the lens cap or gray card present in front of the camera module **180**.

In operation **907**, according to certain embodiments, the electronic device **301** may correct at least one image among a plurality of images obtained using the camera module **180** using correction values (e.g., correction values calculated in operation **905**). For example, the electronic device **301** may adjust the white balance of at least one image among a plurality of images using the correction values (e.g., R gain, G gain, and/or B gain). For example, the electronic device **301** may correct the image used for calculation of the correction values (e.g., one image of the first image or second image obtained in operation **901** or **903**), using the correction values. As another example, the electronic device **301** may correct another image distinguished from the first image and second image obtained in operations **901** and **903**, using the correction values.

Although FIG. **9** illustrates image white balancing, the embodiments are not limited to white balancing. According to an embodiment, the electronic device **301** may enhance the image quality using a scheme other than the above-described white balancing and, to that end, may compare the first image obtained in the first state disclosed in operation **901** and the second image obtained in the second state disclosed in operation **903**.

According to an embodiment, the electronic device **301** may calculate the color temperature of the external light source by comparing the first image and the second image and correct at least one image using the color temperature of the external light source.

FIG. **10** is a flowchart illustrating operations of an electronic device according to certain embodiments. FIG. **10** is described with reference to FIGS. **4** and **7**.

Referring to FIG. **10**, in operation **1001**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may obtain a first image using the camera module **330** in a first state (e.g., active state or UDC-On state) in which the first portion (e.g., **499** or **710**) of the display **320** is in a first mode (e.g., a mode in which a partial screen is displayed), based on a request for executing a camera application. For example, the electronic device **301** may display a first screen using the display **320** before the request for executing the camera application is identified and, as the request for executing the camera application is identified, may obtain the first image using the camera module **330** in the state of displaying the partial screen corresponding to a portion of the first screen in the first portion (e.g., **499** or **710**) of the display **320**.

In operation **1003**, according to certain embodiments, the electronic device **301** may change the mode of the first portion (e.g., **499** or **710**) of the display **320** and may obtain the second image using the camera module **330** in the second

state (e.g., inactive state or UDC-Off state) in which the first portion (e.g., **499** or **710**) of the display **320** is in the second mode (e.g., a mode in which no partial screen is displayed). For example, after obtaining the first image in operation **1001** as the request for executing the camera application is identified, the electronic device **301** may obtain the second image using the camera module **330** in the state in which no screen is displayed in the first portion (e.g., **499** or **710**) of the display **320** before the camera application is executed. As another example, after obtaining the first image in operation **1001** as the request for executing the camera application is identified, the electronic device **301** may obtain the second image using the camera module **330** in the state in which no screen is displayed in the first portion (e.g., **499** or **710**) of the display **320** while the camera application is running. As another example, after obtaining the first image in operation **1001** as the request for executing the camera application is identified, the electronic device **301** may obtain the second image using the camera module **330** in the state in which no screen is displayed in the first portion (e.g., **499** or **710**) of the display **320** after the camera application is executed.

In certain embodiments, the first image and the second image may be captured contemporaneously with each other. For example, the second image may be captured in response to capturing the first image. In certain embodiments, the first image and the second image may be captured within a time frame, such that an image captured of the scene that is proximate to the electronic device **101** is not expected to be perceptibly different. In certain embodiments, the first image and the second image may be captured within 1 second of each other. In certain embodiments, the first image and the second image may be captured within 3 seconds of each other.

In operation **1005**, according to certain embodiments, the electronic device **301** may calculate the correction values by comparing the first image and the second image, which has been described in connection with operation **905**.

FIG. **11** is a flowchart illustrating operations of an electronic device according to certain embodiments. FIG. **11** is described with reference to FIGS. **4** and **7**.

Referring to FIG. **11**, in operation **1101**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may obtain a first image using the camera module **330** in a first state (e.g., inactive state or UDC-Off state) in which the first portion (e.g., **499** or **710**) of the display **320** is in a first mode (e.g., a mode in which no partial screen is displayed), based on a capture request. For example, while the camera application is running, and before no capture request is identified, the electronic device **301** may obtain the first image using the camera module **330** as a capture request is identified in the state in which no screen is displayed in the first portion (e.g., **499** or **710**) of the display **320** (e.g., inactive state or UDC-Off state).

In operation **1103**, according to certain embodiments, the electronic device **301** may change the mode of the first portion (e.g., **499** or **710**) of the display **320** and may obtain the second image using the camera module **330** in the second state (e.g., active state or UDC-On state) in which the first portion (e.g., **499** or **710**) of the display **320** is in the second mode (e.g., a mode in which a partial screen is displayed). For example, after obtaining the first image in operation **1101** as a capture request is identified, the electronic device **301** may display a partial screen (e.g., one of a white screen, a red screen, a green screen, or a blue screen) in the first portion (e.g., **499** or **710**) of the display **320** and obtain the second image using the camera module **330** in the state of displaying the partial screen.

In certain embodiments, the first image and the second image may be captured contemporaneously with each other. For example, the second image may be captured in response to capturing the first image. In certain embodiments, the first image and the second image may be captured within a time frame, such that an image captured of the scene that is proximate to the electronic device **101** is not expected to be perceptibly different. In certain embodiments, the first image and the second image may be captured within 1 second of each other. In certain embodiments, the first image and the second image may be captured within 3 seconds of each other.

According to an embodiment, after obtaining the second image, the electronic device **301** may change the mode of the first portion (e.g., **499** or **710**) of the display **320** into the first mode (e.g., a mode in which no partial screen is displayed) in operation **1103**.

In operation **1105**, according to certain embodiments, the electronic device **301** may calculate the correction values by comparing the first image and the second image, which has been described in connection with operation **905**.

According to an embodiment, the electronic device **301** may correct the first image obtained in operation **1101**, using the correction values calculated in operation **1105**. According to another embodiment, the electronic device **301** may correct at least one image obtained later, using the correction values calculated in operation **1105**.

FIG. **12** is a flowchart illustrating operations of an electronic device according to certain embodiments. FIG. **12** is described with reference to FIGS. **4** and **7**.

Referring to FIG. **12**, in operation **1201**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may obtain the first image according to a designated period while the camera application is running. For example, the electronic device **301** may obtain the first image using the camera module **330** in the first state (e.g., inactive state or UDC-Off state) in which the first portion (e.g., **499** or **710**) of the display **320** is in the first mode (e.g., a mode in which no partial screen is displayed) according to the preset period in the state in which the camera application is running.

In operation **1203**, according to certain embodiments, immediately after performing operation **1201**, the electronic device **301** may change the mode of the first portion (e.g., **499** or **710**) of the display **320** and may obtain the second image using the camera module **330** in the second state (e.g., active state or UDC-On state) in which the first portion (e.g., **499** or **710**) of the display **320** is in the second mode (e.g., a mode in which a partial area is displayed). For example, after obtaining the first image in operation **1201** according to the designated period in the state in which the camera application is running, the electronic device **301** may display a partial screen (e.g., one of a white screen, a red screen, a green screen, or a blue screen) in the first portion (e.g., **499** or **710**) of the display **320** and obtain the second image using the camera module **330** in the state of displaying the partial screen.

According to an embodiment, after obtaining the second image, the electronic device **301** may change the mode of the first portion (e.g., **499** or **710**) of the display **320** into the first mode (e.g., a mode in which no partial screen is displayed) in operation **1203**.

In operation **1205**, according to certain embodiments, the electronic device **301** may calculate the correction values by comparing the first image and the second image, which has been described in connection with operation **905**.

According to an embodiment, the electronic device **301** may correct at least one image obtained later, using the correction values calculated in operation **1205**. For example, the electronic device **301** may periodically calculate the correction values through operation **1201**, operation **1203**, and operation **1205** and, if calculating first correction values at a first time according to a period, correct at least one image among a plurality of images obtained between the first time and a second time using the first correction values until before calculating second correction values at the second time according to a next period. Thereafter, if calculating the second correction values at the second time, the electronic device **301** may correct at least one image among the plurality of images obtained after the second time using the second correction values.

FIG. **13** is a flowchart illustrating operations of an electronic device according to certain embodiments. FIG. **13** is described with reference to FIGS. **4** and **7**.

Referring to FIG. **13**, in operation **1301**, according to certain embodiments, the electronic device **301** (e.g., the processor **120** of the electronic device **101** of FIG. **1** or the image signal processor **260** of FIG. **2**) may identify first data of a first area of a first image. In operation **1303**, according to certain embodiments, the electronic device **301** may identify second data of a second area of a second image, corresponding to the first area of the first image. The operation of identifying data in operations **1301** and **1303** may be understood in a similar manner as described in connection with the operations of obtaining the first image and the second image in operations **901** and **903** and comparing the first data of the first image and the second data of the second image in operation **905**.

In operation **1305**, according to certain embodiments, the electronic device **301** may identify third data (e.g., screen brightness and/or screen color information) of the first portion (e.g., **499** or **710**) of the display **320**. The data of the first portion (e.g., **499** or **710**) may mean data related to a state in which a screen is displayed in the first portion (e.g., **499** or **710**) or a state in which no screen is displayed. For example, in the state (e.g., active state or UDC-On state) in which a screen is displayed in the first portion (e.g., **499** or **710**), the electronic device **301** may identify the value related to the type of the screen displayed in the first portion (e.g., **499** or **710**), screen brightness, and/or color of the screen. For example, the electronic device **301** may identify whether a partial screen is displayed in the first portion (e.g., **499** or **710**) of the display **320** in operation **1301** and/or operation **1303** and, if a partial screen is displayed in the first portion (e.g., **499** or **710**) of the display **320** in at least one operation of operation **1301** or operation **1303**, may identify data (e.g., screen brightness, and/or screen color information, third data) related to the partial screen displayed in the first portion (e.g., **499** or **710**) of the display **320** in at least one operation of operation **1301** or operation **1303**.

In operation **1305**, according to certain embodiments, the electronic device **301** may calculate the correction values (e.g., R gain, G gain, and/or B gain used for white balancing), based on the first data (e.g., R level, G level, and/or B level of the first area) of the first area of the first image, the second data (e.g., R level, G level, and/or B level of the second area) of the second area of the second image corresponding to the first area of the first image, and the third data (e.g., screen brightness and/or screen color information) of the first portion (e.g., **499** or **710**) of the display **320**.

By providing a method for providing an image according to certain embodiments, it is possible to provide a method capable of quickly performing white balancing according to a difference between captured images caused depending on the state of the display (e.g., the display **320**) using the display (e.g., the display **320**) (e.g., using the display as a lens cap) in the electronic device (e.g., the electronic device **101** or the electronic device **301**) including the under display camera (UDC) (e.g., the camera module **330**).

By providing a method for providing an image and an electronic device (e.g., the electronic device **101** or the electronic device **301**) supporting the same according to certain embodiments, it is possible to perform white balancing using the front camera (e.g., the camera module **330** (e.g., the camera facing in the direction in which the display (e.g., the display **320**) of the electronic device faces).

By providing a method for providing an image and an electronic device (e.g., the electronic device **101** or electronic device **301**) supporting the same according to certain embodiments, it is possible to simplify conventional complicated software processing for white balancing and to simplify the hardware device to thereby reduce the manufacturing costs of the electronic device (e.g., the electronic device **101** or electronic device **301**).

It may be understood by one of ordinary skill in the art that certain embodiments described herein may be applied mutually organically within the applicable scope. For example, one of ordinary skill in the art may understand that at least some operations of an embodiment of the disclosure may be omitted and applied and that at least some operations of an embodiment and at least some operations of another embodiment may be organically combined and applied.

According to certain embodiments, an electronic device (e.g., the electronic device **301** or the electronic device **101**) may comprise a display (e.g., the display **320** or the display module **160**); a camera (e.g., the camera module **330** or the camera module **180**) disposed under the display (e.g., the display **320** or the display module **160**); and a processor (e.g., the processor **120** and/or the image signal processor **260**) configured to obtain a first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) using the camera (e.g., the camera module **330** or the camera module **180**) in a first state in which a first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) corresponding to a position where the camera (e.g., the camera module **330** or the camera module **180**) is disposed is in a first mode, obtain a second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) using the camera (e.g., the camera module **330** or the camera module **180**) in a second state in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) is in a second mode, calculate correction values, based on first data for a first area of the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) and second data for a second area of the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) corresponding to the first area of the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**), and correct at least one

image among a plurality of images obtained using the camera (e.g., the camera module **330** or the camera module **180**), using the correction values. One of obtaining the first image and obtaining the second image is responsive to the other of obtaining the first image and the second image.

According to certain embodiments, the first state may be a state (e.g., the state of (a) of FIG. **7** or one state of (b), (c), (d), or (e) of FIG. **8**) in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) is active, and the second state may be a state (e.g., the state of (b) of FIG. **7** or the state of (a) of FIG. **8**) in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) is inactive.

According to certain embodiments, the processor (e.g., the processor **120** and/or the image signal processor **260**) may be configured to obtain the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) based on a request for executing a camera (e.g., the camera module **330** or the camera module **180**) application and, after obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**), obtain the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, the processor (e.g., the processor **120** and/or the image signal processor **260**) may be configured to obtain the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) based on a capture request, and after obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**), obtain the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, the processor (e.g., the processor **120** and/or the image signal processor **260**) may be configured to correct the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**), using the correction values.

According to certain embodiments, the processor (e.g., the processor **120** and/or the image signal processor **260**) may be configured to obtain the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) according to a preset period, while the camera (e.g., the camera module **330** or the camera module **180**) application is running, and after obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**), obtain the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, the processor (e.g., the processor **120** and/or the image signal processor **260**) may be configured to identify third data related to a brightness and/or color of a screen displayed in the first portion (e.g., the first portion **499** or the first portion **710**) in the first state (e.g., the state of (a) of FIG. **7** or one state of (b), (c), (d), or (e) of FIG. **8**) in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) is active and calculate the correction values, based on the first data, the second data, and the third data.

According to certain embodiments, the processor (e.g., the processor **120** and/or the image signal processor **260**) may be configured to correct the at least one image by adjusting a white balance of the at least one image, based on the correction values, and wherein the correction values include an R gain, a G gain, and a B gain.

According to certain embodiments, the first data may include an R level, G level, and B level of the first area. The second data may include an R level, G level, and B level of the second area. The first area may be an area designated as a center area of the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**). The second area may be an area designated as a center area of the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) and the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) may be obtained using light emitted from a light source and introduced through the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**).

According to certain embodiments, a method for operating an electronic device (e.g., the electronic device **301** or the electronic device **101**) including a display (e.g., the display **320** or the display module **160**) and a camera (e.g., the camera module **330** or the camera module **180**) disposed under the display (e.g., the display **320** or the display module **160**) may comprise obtaining a first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) using the camera (e.g., the camera module **330** or the camera module **180**) in a first state in which a first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) corresponding to a position where the camera (e.g., the camera module **330** or the camera module **180**) is disposed is in a first mode, obtaining a second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) using the camera (e.g., the camera module **330** or the camera module **180**) in a second state in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) is in a second mode, calculating correction values, based on first data for a first area of the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) and second data for a second area of the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) corresponding to the first area of the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**), and correcting at least one image among a plurality of images obtained using the camera (e.g., the camera module **330** or the camera module **180**), using the correction values. One of obtaining the first image and obtaining the second image is responsive to the other of obtaining the first image and the second image.

According to certain embodiments, the first state may be a state (e.g., the state of (a) of FIG. **7** or one state of (b), (c), (d), or (e) of FIG. **8**) in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) is active, and the second state may be a state (e.g., the state of (b) of FIG. **7** or the state of (a) of FIG. **8**) in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display is inactive.

According to certain embodiments, obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) may include obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) based on an request for executing a camera (e.g., the camera module **330** or the camera module **180**) application. Obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) may include obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) after obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) may include obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) based on a capture request. Obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) may include obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) after obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, correcting the at least one image using the correction values may include correcting the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) using the correction values.

According to certain embodiments, obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) may include obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**), according to a preset period, in a state in which the camera (e.g., the camera module **330** or the camera module **180**) application is running. Obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) may include obtaining the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) after obtaining the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, the method may further comprise identifying third data related to a brightness and/or color of a screen displayed in the first portion (e.g., the first portion **499** or the first portion **710**) in the first state (e.g., the state of (a) of FIG. **7** or one state of (b), (c), (d), or (e) of FIG. **8**) in which the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**) is active. Calculating the correction values may include calculating the correction values, based on the first data, the second data, and the third data.

According to certain embodiments, correcting the at least one image using the correction values may include correcting the at least one image, by adjusting a white balance of the at least one image, based on the correction values.

According to certain embodiments, the first data may include an R gain, G gain, and B gain of the first area. The second data may include an R gain, G gain, and B gain of the second area. The first area may be an area designated as a center area of the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**). The second area may be an area designated as a center area of the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**).

According to certain embodiments, the first image (e.g., an image obtained in one state of (a) or (b) of FIG. **7** or an image obtained in one state of (a), (b), (c), (d), or (e) of FIG. **7**) and the second image (e.g., an image obtained in the other state of (a) or (b) of FIG. **7** or an image obtained in another state of (a), (b), (c), (d), or (e) of FIG. **7**) may be obtained using light emitted from a light source and introduced through the first portion (e.g., the first portion **499** or the first portion **710**) of the display (e.g., the display **320** or the display module **160**).

The electronic device according to certain embodiments of the disclosure may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smart phone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, or a home appliance. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

It should be appreciated that certain embodiments of the present disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. With regard to the description of the drawings, similar reference numerals may be used to refer to similar or related elements. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as "1st" and "2nd," or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively", as "coupled with," "coupled to," "connected

with," or "connected to" another element (e.g., a second element), it means that the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

As used herein, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

Certain embodiments as set forth herein may be implemented as software (e.g., the program **140**) including one or more instructions that are stored in a storage medium (e.g., internal memory **136** or external memory **138**) that is readable by a machine (e.g., the electronic device **101**). For example, a processor (e.g., the processor **120**) of the machine (e.g., the electronic device **101**) may invoke at least one of the one or more instructions stored in the storage medium, and execute it, with or without using one or more other components under the control of the processor. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a complier or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the term "non-transitory" simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

According to an embodiment, a method according to certain embodiments of the disclosure may be included and provided in a computer program product. The computer program products may be traded as commodities between sellers and buyers. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., Play Store™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

According to certain embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities. Some of the plurality of entities may be separately disposed in different components. According to certain embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to certain embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to certain embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

Although certain non-limiting embodiments have been described with a degree of particularity, it shall be understood that the embodiments can be modified, where certain elements are added, omitted, or substituted without departing from the spirit and scope of the invention as set forth in the following claims, and equivalents thereof.

What is claimed is:

1. An electronic device comprising,

a display;

a camera disposed under the display; and

a processor configured to,

obtain a first image using the camera in a first state in which a first portion of the display corresponding to a position where the camera is disposed is in a first mode,

obtain a second image, using the camera in a second state in which the first portion of the display is in a second mode,

calculate correction values, based on first data for a first area of the first image and second data for a second area of the second image, wherein the second area of the second image corresponds to the first area of the first image, and

correct at least one image among a plurality of images, using the correction values,

wherein one of obtaining the first image and obtaining the second image is responsive to the other of obtaining the first image and the second image.

2. The electronic device of claim **1**, wherein the first state is a state in which the first portion of the display is active, and the second state is a state in which the first portion of the display is inactive.

3. The electronic device of claim **2**, wherein the processor is configured to obtain the first image based on a request for executing a camera application and, after obtaining the first image, obtain the second image.

4. The electronic device of claim **2**, wherein the processor is configured to obtain the second image based on a capture request, and

after obtaining the second image, obtain the first image.

5. The electronic device of claim **4**, wherein the processor is configured to correct the second image, using the correction values.

6. The electronic device of claim **2**, wherein the processor is configured to obtain the second image according to a preset period, while a camera application is running, and

after obtaining the second image, obtain the first image.

7. The electronic device of claim **2**, wherein the processor is configured to identify third data related to a brightness and/or color of a screen displayed in the first portion in the first state in which the first portion of the display is active and calculate the correction values, based on the first data, the second data, and the third data.

8. The electronic device of claim **1**, wherein the processor is configured to correct the at least one image by adjusting a white balance of the at least one image, based on the correction values, and wherein the correction values include an R gain, a G gain, and a B gain.

9. The electronic device of claim **8**,

wherein the first data includes an R level, G level, and B level of the first area,

wherein the second data includes an R level, G level, and B level of the second area,

wherein the first area is an area designated as a center area of the first image, and

wherein the second area is an area designated as a center area of the second image.

10. The electronic device of claim **1**, wherein the first image and the second image are obtained using light emitted from a light source and introduced through the first portion of the display.

11. A method for operating an electronic device including a display and a camera disposed under the display, the method comprising,

obtaining a first image using the camera in a first state in which a first portion of the display corresponding to a position where the camera is disposed is in a first mode,

obtaining a second image using the camera in a second state in which the first portion of the display is in a second mode,

calculating correction values, based on first data for a first area of the first image and second data for a second area of the second image, wherein the second area of the second image corresponds to the first area of the first image, and

correcting at least one image among a plurality of images obtained using the camera, using the correction values,

wherein one of obtaining the first image and obtaining the second image is responsive to the other of obtaining the first image and the second image.

12. The method of claim **11**,

wherein the first state is a state in which the first portion of the display is active, and

wherein the second state is a state in which the first portion of the display is inactive.

13. The method of claim **12**, wherein obtaining the first image includes obtaining the first image based on a request for executing a camera application, and

wherein obtaining the second image includes obtaining the second image after obtaining the first image.

14. The method of claim **12**, wherein obtaining the second image includes obtaining the second image based on a capture request, and

wherein obtaining the first image includes obtaining the first image after obtaining the second image.

15. The method of claim **14**, wherein correcting the at least one image using the correction values includes correcting the second image using the correction values.

16. The method of claim **12**, wherein obtaining the second image includes obtaining the second image, according to a preset period, in a state in which a camera application is running, and

wherein obtaining the first image includes obtaining the first image after obtaining the second image.

17. The method of claim **12**, further comprising identifying third data related to a brightness and/or color of a screen displayed in the first portion in the first state in which the first portion of the display is active,

wherein calculating the correction values includes calculating the correction values, based on the first data, the second data, and the third data.

18. The method of claim **11**, wherein correcting the at least one image using the correction values includes correcting the at least one image, by adjusting a white balance of the at least one image, based on the correction values.

19. The method of claim **18**,

wherein the first data includes an R gain, G gain, and B gain of the first area,

wherein the second data includes an R gain, G gain, and B gain of the second area,

wherein the first area is an area designated as a center area of the first image, and

wherein the second area is an area designated as a center area of the second image.

20. The method of claim **11**, wherein the first image and the second image are obtained using light emitted from a light source and introduced through the first portion of the display.

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